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#### Technical note

# Mechanical performances of steel fiber reinforced high strength concrete disc under cyclic loading

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## 1. Introduction

High strength concrete, which has been extensively adopted in long-span bridges, high-rise buildings, piles and underground structure in high ground stress, etc., can provide many structure advantages in terms of strength, stiffness and structure, and thus lead to high load capacity, small cross-section and low costs [1–6]. However, the laboratory tests indicated the high strength concrete always behaved in a brittle manner that the load rapid decrease in the post-peak stage [7–10]. In order to guarantee a ductile behaviour of the high strength concrete, the steel fibers are always included into the concrete matrix to obtain high ductil-ity and deformability of concrete.

Considerable experiments, analytical studies and numerical modeling have therefore been conducted to investigate the mechanical performance of steel fiber reinforced concrete. A stress-strain response for fiber reinforced concrete was suggested by Fanella and Naaman [11] after a series of laboratory tests. Hsu and Hsu [12] also carried out tests to obtain the stress-strain responses of steel fiber reinforced high strength. Ezeldin and Balaguru [13] proposed a stress-strain response of fiber reinforced concrete with concrete strength ranging from 35 MPa to 85 MPa. Nataraja et al. [14] suggested a theoretical model for the steel fiber reinforced concrete, which consists of two branches, the ascending

#### ABSTRACT

A comparative study on high strength concrete discs reinforced with steel fibers under monotonic loading and cyclic loading was conducted in this contribution. A total of 40 specimens with steel fiber volume fraction ranging from 0.0% to 4% were tested. An investigation was performed on the influences of steel fiber volume fraction on fracture pattern, load-displacement response, deformation and strength. The influences of loading conditions on the mechanical performances of test specimens were also discussed in detail. Based on the experimental results, empirical equations for predicting the disc strength and deformation of high strength concrete reinforced with steel fibers were proposed.

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and descending ones. The mechanical performances of steel fiber reinforced high strength concrete compared with the plain concrete were carefully studied by Lim and Nawy [15]. The influences of steel fibers were tested by Foster and Attard [16] through the concentric or eccentric compression of concrete columns. Foster [17] also investigated the influences of steel fibers on the c ductility of concrete columns. Tokgoz et al. presented an experimental study on the behaviour of eccentrically loaded plain and steel fiber high strength reinforced concrete and concrete-encased composite column. Ramakrishnan et al. [18] indicated that the hookedend steel fibers can enable the concretes to withstand more impact loads and that the fibers provide at least a fivefold increase in the impact resistance. Eren and Celik [19] investigated the influences of steel fibers on concrete strength and indicated that the fiber volume and fiber aspect ratio governed the compressive strength of the concrete.

Most of the previous work focuses on the behaviour of steel fiber reinforced concrete under static load. These studies are fundamental and have contributed to a better understanding of the behaviour of steel fiber reinforced high strength concrete, which has in turn led to a higher quality design and an increase in safety. However, the mechanical performances of steel fiber reinforced concrete under cyclic loading are still unclear.

This research study focuses primarily on the mechanical performances of steel fiber reinforced concrete under fatigue splitting. A total of 40 concrete discs were tested with different steel fiber con-







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tents. 20 discs were tested under fatigue splitting and the other discs were tested under monotonic loading for comparing purpose.

#### 2. Specimen preparations and testing

The Portland cement was adopted with crushed stone having a maximum particle size of 5 mm and fine sand having a fineness modulus of 2.6. The 13-mm long steel fibers with a diameter of 0.2 mm were used. The concrete mix proportions were summarized in Table 1. The tensile strength, elastic modulus and percentage elongation for the steel fibers were 2500 MPa, 210 GPa and 4%. As listed in Table 2, four groups of specimens were tested, and the fiber volume fraction ( $\varphi$ ) was 0% (A group), 1% (B group), 2% (C group) and 4% (D group), respectively.

The steel fibers were added after the concrete ingredients were mixed. Then the ASTM Standard mixing procedure was followed of 3-min mixing, 3-min rest, and 2-min mixing. The mixed steel fiber-

#### Table 1

Concrete mix proportions (kg/m<sup>3</sup>).

reinforced concrete was firstly casted in the wood mould with the dimension of  $200 \times 200 \times 120$  mm. Then the specimens were placed in a 28°C room for curing after removal from the mold 24 h later. After 28 days, the specimens were cored in the laboratory using a 50 mm diameter drill bit and machined to the desired sizes. According to the ISRM suggested method [20] the diameter and height of these specimens were 49.9 mm and 25 mm, respectively, giving a thickness-to-diameter ratio (*t/d*) of 0.5. The errors in specimen dimensions were within ±0.5 mm, and the parallelism of the specimen ends was within ±0.02 mm after hand polishing. Other parameters for the concrete were listed in Table 3.

All specimens were tested under a universal testing machine with a capacity of 1500 kN. Fig. 1 gave a general view of the test setups. The applied load was controlled and measured by the electronic load transducer. The loads were applied by two steel wires between the loading plate and the specimens. The deformations of the tested specimen were measured by the displacement transducers in x direction and y direction. During the loading process,

Group ID	Cement	Sand	Aggregates	Silica fume	Steel fiber	Water reduce	Water
А	780	412	620	246	0	20.5	195
В	780	412	620	246	76.3	20.5	195
С	780	412	620	246	152.6	20.5	195
D	780	412	620	246	305.2	20.5	195

#### Table 2

Materials parameters and test results for disc.

Monotonic Loading         0         A6         49,7         28.8         12,19         5.42         -0.16         0.470           A7         49,7         28.8         15.39         6.85         -0.113         0.41           A9         49,7         28.8         15.39         6.85         -0.161         0.682           A10         49,7         28.8         14.08         6.26         -0.106         0.682           1         86         49,7         28.8         15.52         7.34         -0.151         0.344           1         87         49,7         28.8         13.36         6.16         -0.083         0.551           1         89         49,7         28.8         13.86         6.16         -0.033         0.615           2         6         49,7         28.8         13.86         6.16         -0.033         0.615           2         6         49,7         28.8         13.86         6.16         -0.033         0.615           2         6         49,7         28.8         20.82         10.46         -0.263         0.598           2         10         49,7         28.8         23.64         10	Loading	Q/%	Specimen ID	D/mm	L/mm	P/kN	<i>R</i> <sub>L</sub> /MPa	X/mm	Y/mm
	Monotonic Loading	0	A6	49.7	28.8	12.19	5.42	-0.116	0.470
K         497         28.8         15.39         6.85         -0.113         0.41           N9         497         28.8         14.08         6.26         -0.106         0.682           N10         49.7         28.8         16.52         7.34         -0.151         0.3341           B7         49.7         28.8         15.75         7.00         -0.116         0.392           B8         49.7         28.8         13.86         6.16         -0.0931         0.415           B9         49.7         28.8         13.86         6.16         -0.030         0.615           C6         49.7         28.8         12.88         7.44         -0.122         0.633           C7         49.7         28.8         12.88         7.04         -0.122         0.633           C8         49.7         28.8         20.87         7.04         -0.203         0.764           P1         49.7         28.8         24.64         10.1         -0.228         0.690           C9         49.7         28.8         24.76         11.01         -0.236         0.581           D9         49.7         28.8         24.76         11.01	_		A7	49.7	28.8	9.61	4.27	-0.087	0.252
A949.728.813.756.11-0.1610.66821B649.728.816.527.34-0.1510.342B749.728.815.757.00-0.1160.392B849.728.813.976.21-0.0910.437B949.728.813.866.16-0.0830.551B1049.728.813.866.16-0.0830.551C749.728.815.837.04-0.1920.633C849.728.815.837.04-0.1920.633C849.728.816.837.04-0.2630.598C949.728.819.688.75-0.1430.403C949.728.820.499.11-0.2070.676D749.728.823.6410.11-0.2280.690D849.728.823.6410.51-0.2400.811D949.728.823.6410.51-0.2400.811D949.728.823.6410.51-0.2400.811A149.728.823.6410.51-0.2631.066A249.728.823.6410.51-0.2631.066A349.728.823.6410.51-0.2631.066A449.728.823.6410.51-0.2631.066A449.728.415.146.83-0.16 <td></td> <td></td> <td>A8</td> <td>49.7</td> <td>28.8</td> <td>15.39</td> <td>6.85</td> <td>-0.113</td> <td>0.41</td>			A8	49.7	28.8	15.39	6.85	-0.113	0.41
No49.728.814.086.26-0.1060.6821B649.728.815.757.30-0.1510.342B749.728.813.976.21-0.0910.437B849.728.813.976.21-0.0910.437B949.728.813.666.16-0.0830.651C649.728.8017.677.86-0.1300.615C749.728.815.837.04-0.1920.633C849.728.815.837.04-0.1920.633C949.728.820.499.11-0.2070.676C949.728.820.499.11-0.2070.676D749.728.820.499.11-0.2070.676D749.728.823.4210.41-0.2310.854D749.728.823.4210.41-0.2310.854D849.728.823.4210.41-0.2310.854D1049.728.823.4210.41-0.2310.854D3049.728.613.145.9-0.0810.471A949.728.613.145.9-0.0810.471D1049.728.613.145.9-0.0810.471A949.728.613.145.9-0.0810.471A949.728.617.147.68-0.256 <td< td=""><td></td><td></td><td>A9</td><td>49.7</td><td>28.8</td><td>13.75</td><td>6.11</td><td>-0.161</td><td>0.645</td></td<>			A9	49.7	28.8	13.75	6.11	-0.161	0.645
1         86         49.7         28.8         15.22         7.34         -0.151         0.344           87         49.7         28.8         13.97         6.21         -0.091         0.437           18         49.7         28.8         13.97         6.21         -0.091         0.437           19         49.7         28.8         13.86         6.16         -0.083         0.551           2         6.6         49.7         28.8         12.87         9.28         -0.236         0.704           1         6.7         49.7         28.8         20.87         9.28         -0.236         0.598           1         6.8         49.7         28.8         19.08         8.75         -0.143         0.403           1.0         1.0         49.7         28.8         20.49         9.11         -0.207         0.576           1.0         1.0         49.7         28.8         24.96         1.01         -0.228         0.699           1.0         1.0         49.7         28.8         12.13         -0.251         0.56           1.0         1.0         49.7         28.8         13.14         5.9         -0.081         <			A10	49.7	28.8	14.08	6.26	-0.106	0.682
K         97         28.8         15.75         7.00         -0.116         0.392           B8         49.7         28.8         13.97         6.21         -0.091         0.437           B9         49.7         28.8         13.86         6.16         -0.083         0.551           B10         49.7         28.8         13.86         6.16         -0.083         0.615           C6         49.7         28.8         15.83         7.04         -0.130         0.615           C7         49.7         28.8         15.83         7.04         -0.192         0.633           C8         49.7         28.8         19.68         8.75         -0.143         0.403           C9         49.7         28.8         20.49         9.11         -0.263         0.598           C10         49.7         28.8         24.76         11.01         -0.228         0.699           D10         49.7         28.8         23.42         10.51         -0.240         0.81           D10         49.7         28.8         23.42         10.51         -0.21         0.58           D10         49.7         28.8         27.28         12.13 <td></td> <td>1</td> <td>B6</td> <td>49.7</td> <td>28.8</td> <td>16.52</td> <td>7.34</td> <td>-0.151</td> <td>0.344</td>		1	B6	49.7	28.8	16.52	7.34	-0.151	0.344
KB849.728.813.976.21-0.0910.437B949.728.813.866.16-0.0830.551B1049.728.8017.677.86-0.1300.615C749.728.815.837.04-0.1920.633C849.728.815.837.04-0.1920.633C949.728.819.688.75-0.1430.403C949.728.820.499.11-0.2070.676C949.728.823.6410.51-0.2280.690D749.728.823.6410.51-0.2400.818D849.728.823.6410.51-0.2400.818D949.728.823.6410.51-0.2400.818D1049.728.823.6410.51-0.2400.818D1049.728.823.6410.51-0.2400.818A449.728.823.6410.51-0.2100.858A549.728.821.8513.145.9-0.0180.471A649.728.211.165.07-0.2100.581A649.728.211.165.07-0.2100.581A649.728.415.146.82-0.1790.526A649.728.617.147.68-0.2551.316B749.728.617.146.82 <td></td> <td></td> <td>B7</td> <td>49.7</td> <td>28.8</td> <td>15.75</td> <td>7.00</td> <td>-0.116</td> <td>0.392</td>			B7	49.7	28.8	15.75	7.00	-0.116	0.392
k         b         49.7         28.8         13.66         6.16         -0.083         0.551           B10         49.7         28.80         17.67         7.86         -0.236         0.704           C7         49.7         28.8         20.87         9.28         -0.236         0.704           C7         49.7         28.8         19.68         8.75         -0.143         0.403           C8         49.7         28.8         20.49         9.11         -0.226         0.598           C10         49.7         28.8         20.49         9.11         -0.228         0.600           C10         49.7         28.8         20.49         9.11         -0.228         0.600           D7         49.7         28.8         23.64         10.51         -0.240         0.811           D8         49.7         28.8         23.42         10.41         -0.251         0.854           D10         49.7         28.8         23.42         10.41         -0.210         0.584           A2         49.7         28.2         21.15         5.07         -0.145         0.792           S2         49.7         28.2         11.17 <td></td> <td></td> <td>B8</td> <td>49.7</td> <td>28.8</td> <td>13.97</td> <td>6.21</td> <td>-0.091</td> <td>0.437</td>			B8	49.7	28.8	13.97	6.21	-0.091	0.437
Second Second			B9	49.7	28.8	13.86	6.16	-0.083	0.551
2         66         49,7         28,8         20,87         9,28         -0.236         0,704           C7         49,7         28,8         15,83         7,04         -0.192         0,633           C8         49,7         28,8         19,68         8,75         -0.143         0,403           C9         49,7         28,8         20,49         9,11         -0.207         0,676           10         49,7         28,8         20,49         9,11         -0.228         0,600           07         49,7         28,8         20,49         9,11         -0.228         0,600           08         49,7         28,8         23,64         10,51         -0.240         0,811           08         49,7         28,8         23,64         10,51         -0.240         0,811           09         49,7         28,8         23,64         10,51         -0.240         0,811           08         49,7         28,8         23,64         10,51         -0.210         0,814           10         49,7         28,2         11,16         5,07         -0.210         0,814           10         49,7         28,2         11,17			B10	49.7	28.80	17.67	7.86	-0.130	0.615
C7         49,7         28,8         15,83         7,04         -0,192         0,633           C8         49,7         28,8         19,68         8,75         -0,143         0,403           C9         49,7         28,2         23,02         10,46         -0,263         0,598           C10         49,7         28,8         24,76         11,01         -0,228         0,690           D7         49,7         28,8         23,64         10,51         -0,240         0,811           D9         49,7         28,8         23,64         10,51         -0,240         0,811           D9         49,7         28,8         23,64         10,51         -0,258         1,006           D10         49,7         28,8         23,42         10,41         -0,213         0,854           A2         49,7         28,8         23,42         10,41         -0,210         0,814           A3         49,7         28,8         23,42         1,416         -0,011         0,515           A4         49,7         28,2         11,17         5,07         -0,145         0,720           A4         49,7         28,2         11,17         5		2	C6	49.7	28.8	20.87	9.28	-0.236	0.704
C8         49.7         28.8         19.68         8.75         -0.143         0.403           C9         49.7         28.2         23.02         10.46         -0.203         0.598           C10         49.7         28.8         20.49         9.11         -0.207         0.676           D6         49.7         28.8         24.76         11.01         -0.202         0.690           D8         49.7         28.8         23.64         10.51         -0.240         0.811           D9         49.7         28.8         23.42         10.41         -0.231         0.854           D9         49.7         28.8         23.42         10.41         -0.258         1.006           Cyclic loading         0         A1         49.7         28.8         23.42         10.41         -0.251         0.854           A2         49.7         28.8         23.42         10.41         -0.251         0.854           A4         49.7         28.2         11.16         5.07         -0.145         0.853           A4         49.7         28.2         11.17         5.07         -0.145         0.782           B1         B1 <td< td=""><td></td><td></td><td>C7</td><td>49.7</td><td>28.8</td><td>15.83</td><td>7.04</td><td>-0.192</td><td>0.633</td></td<>			C7	49.7	28.8	15.83	7.04	-0.192	0.633
C9         49.7         28.2         23.02         10.46         -0.263         0.598           4         D6         49.7         28.8         20.49         9.11         -0.207         0.676           D7         49.7         28.8         20.49         9.11         -0.228         0.690           D7         49.7         28.8         19.21         8.54         -0.172         0.538           D8         49.7         28.8         23.64         10.61         -0.240         0.811           D9         49.7         28.8         23.42         10.41         -0.231         0.854           D10         49.7         28.8         27.28         12.13         -0.258         1.006           Cyclic loading         0         A1         49.7         28.2         11.16         5.07         -0.210         0.584           A3         49.7         28.2         11.16         5.07         -0.210         0.584           A4         49.7         28.2         11.17         5.07         -0.145         0.782           B1         B1         49.7         28.2         11.17         5.07         -0.145         0.832           B2<			C8	49.7	28.8	19.68	8.75	-0.143	0.403
Cl0         49.7         28.8         20.49         9.11         -0.207         0.676           D6         49.7         28.8         24.76         11.01         -0.228         0.690           D8         49.7         28.8         23.64         10.51         -0.240         0.811           D9         49.7         28.8         23.64         10.51         -0.240         0.811           D9         49.7         28.8         23.42         10.41         -0.238         0.069           D10         49.7         28.8         27.28         12.13         -0.258         0.069           A1         49.7         28.5         13.14         5.9         -0.081         0.471           A3         49.7         28.2         11.16         5.07         -0.145         0.782           A4         49.7         28.2         9.17         4.16         -0.0701         0.551           B1         49.7         28.4         15.13         6.82         -0.179         0.622           B3         49.7         28.4         15.13         6.82         -0.179         0.622           B4         49.7         28.4         15.13         6.82<			C9	49.7	28.2	23.02	10.46	-0.263	0.598
4D649.728.824.7611.01-0.2280.690D749.728.819.218.54-0.1720.538D849.728.823.6410.51-0.2400.811D949.728.823.4210.41-0.2310.854D1049.728.823.4210.41-0.2310.854LD1049.728.827.2812.13-0.2581.00A249.728.513.145.9-0.0810.471A349.728.211.165.07-0.2100.584A449.728.211.165.07-0.2100.584A449.728.211.175.07-0.1450.871A549.728.29.174.16-0.07010.551B249.728.415.136.82-0.1790.622B349.728.415.136.82-0.1790.622B449.728.415.136.82-0.190.622B349.728.415.136.82-0.190.622B449.728.415.146.83-0.160.819B549.728.617.157.42-0.0990.566C149.728.617.157.42-0.0990.566C349.728.617.157.42-0.0990.566C449.728.617.157.42-0.099			C10	49.7	28.8	20.49	9.11	-0.207	0.676
D7         49.7         28.8         19.21         8.54         -0.172         0.538           D8         49.7         28.8         23.62         10.51         -0.240         0.811           D9         49.7         28.8         23.62         12.13         -0.258         1.006           Cyclic loading         0         A1         49.7         28.5         13.14         5.9         -0.081         0.471           A2         49.7         28.2         11.16         5.96         -0.118         0.901           A3         49.7         28.2         11.16         5.07         -0.145         0.782           A4         49.7         28.2         11.17         5.07         -0.145         0.782           A4         49.7         28.2         9.17         4.16         -0.0701         0.551           B2         49.7         28.6         17.14         7.68         -0.285         1.113           B2         49.7         28.4         15.13         6.82         -0.179         0.622           B4         49.7         28.3         13.2         5.98         -0.285         0.833           C1         49.7         28.3<		4	D6	49.7	28.8	24.76	11.01	-0.228	0.690
D8         49.7         28.8         23.64         10.51         -0.240         0.811           D9         49.7         28.8         23.42         10.41         -0.231         0.854           D10         49.7         28.8         27.28         12.13         -0.258         1.006           Cyclic loading         0         A1         49.7         28.5         13.14         5.9         -0.081         0.41           A2         49.7         28.2         11.16         5.07         -0.210         0.584           A3         49.7         28.2         11.16         5.07         -0.210         0.584           A4         49.7         28.2         11.16         5.07         -0.210         0.584           A4         49.7         28.2         11.17         5.07         -0.210         0.584           A5         49.7         28.2         9.17         4.16         -0.0701         0.551           B2         49.7         28.4         15.13         6.82         -0.179         0.622           B4         49.7         28.4         15.13         6.83         -0.116         0.819           C2         C1         49.7<			D7	49.7	28.8	19.21	8.54	-0.172	0.538
D949.728.823.4210.41 $-0.231$ 0.854D1049.728.827.2812.13 $-0.258$ 1.006Cyclic loading0A149.728.513.145.9 $-0.081$ 0.901A249.728.211.165.07 $-0.210$ 0.584A349.728.211.165.07 $-0.210$ 0.584A449.728.211.175.07 $-0.145$ 0.782A549.728.29.174.16 $-0.0701$ 0.513B149.72712.846.09 $-0.270$ 1.335B249.728.617.147.68 $-0.285$ 1.113B349.728.415.136.82 $-0.179$ 0.621B449.728.313.25.98 $-0.285$ 0.833C149.729.617.157.42 $-0.099$ 0.516B549.728.620.499.18 $-0.461$ 1.312C249.728.620.499.18 $-0.407$ 1.066C349.728.620.499.18 $-0.205$ 1.225C449.728.719.128.53 $-0.265$ 1.225C549.728.427.0512.2 $-0.6384$ 1.685D249.728.427.0512.2 $-0.6384$ 1.685D349.728.621.079.44 $-0.328$ 1.685D349.7 <td></td> <td></td> <td>D8</td> <td>49.7</td> <td>28.8</td> <td>23.64</td> <td>10.51</td> <td>-0.240</td> <td>0.811</td>			D8	49.7	28.8	23.64	10.51	-0.240	0.811
D10         49.7         28.8         27.28         12.13         -0.258         1.006           Cyclic loading         0         A1         49.7         28.5         13.14         5.9         -0.081         0.471           A2         49.7         28.2         13.16         6.96         -0.118         0.901           A3         49.7         28.2         11.16         5.07         -0.145         0.782           A4         49.7         28.2         9.17         4.16         -0.0701         0.551           A5         49.7         28.2         9.17         4.16         -0.0701         0.551           B2         49.7         28.4         15.13         6.82         -0.179         0.622           B3         49.7         28.4         15.14         6.83         -0.161         0.819           B4         49.7         28.4         15.14         6.83         -0.161         0.819           C1         49.7         28.3         13.2         5.98         -0.285         0.833           C2         C1         49.7         28.6         20.499         9.18         -0.407         1.066           C3         49.7 </td <td></td> <td></td> <td>D9</td> <td>49.7</td> <td>28.8</td> <td>23.42</td> <td>10.41</td> <td>-0.231</td> <td>0.854</td>			D9	49.7	28.8	23.42	10.41	-0.231	0.854
Cyclic loading         0         A1         49.7         28.5         13.14         5.9         -0.081         0.471           A2         49.7         27.9         15.16         6.96         -0.118         0.901           A3         49.7         28.2         11.16         5.07         -0.210         0.584           A4         49.7         28.2         11.17         5.07         -0.145         0.782           A5         49.7         28.2         9.17         4.16         -0.0701         0.551           B1         81         49.7         28.6         17.14         7.68         -0.270         1.335           B2         49.7         28.4         15.13         6.82         -0.179         0.622           B3         49.7         28.4         15.13         6.82         -0.179         0.622           B4         49.7         28.4         15.14         6.83         -0.0161         0.819           C1         49.7         28.3         13.2         5.98         -0.285         1.312           C2         (1         49.7         28.6         17.15         7.42         -0.099         0.546           C3			D10	49.7	28.8	27.28	12.13	-0.258	1.006
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Cyclic loading	0	A1	49.7	28.5	13.14	5.9	-0.081	0.471
A349.728.211.165.07-0.2100.584A449.728.211.175.07-0.1450.782A549.728.29.174.16-0.07010.5511B149.72712.846.09-0.2701.335B249.728.617.147.68-0.2851.13B349.728.415.136.82-0.1790.622B449.728.313.25.98-0.2850.8332C149.729.319.118.35-0.4511.3122C149.729.617.157.42-0.0990.546C349.728.620.499.18-0.4071.066C349.728.719.128.53-0.2561.225C449.729.317.147.49-0.20690.872A4D149.729.317.147.49-0.20690.872A549.728.421.029.20.3141.081D249.728.427.0512.2-0.5891.685D349.728.621.079.44-0.3281.078D449.728.621.079.44-0.3281.078D449.728.621.079.44-0.3281.049D549.728.223.061.047-0.3281.049			A2	49.7	27.9	15.16	6.96	-0.118	0.901
A449.728.211.175.07-0.1450.782A549.728.29.174.16-0.07010.5511B149.72712.846.09-0.2701.335B249.728.617.147.68-0.1790.622B349.728.415.136.82-0.1790.622B449.728.415.146.83-0.1160.819B549.728.313.25.98-0.2850.8332C149.729.319.118.35-0.4511.312C249.728.620.499.18-0.4071.066C349.728.620.499.18-0.20690.872C449.728.719.128.53-0.2661.225A4D149.729.317.147.49-0.20690.872A4D149.729.421.129.20.3141.081D249.728.427.0512.2-0.5891.685D349.728.621.079.4-0.3281.078D449.728.621.079.31-0.3981.049D349.728.621.098.31-0.3981.049D449.728.621.098.31-0.3981.049D549.728.223.0610.47-0.4291.335			A3	49.7	28.2	11.16	5.07	-0.210	0.584
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			A4	49.7	28.2	11.17	5.07	-0.145	0.782
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			A5	49.7	28.2	9.17	4.16	-0.0701	0.551
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		1	B1	49.7	27	12.84	6.09	-0.270	1.335
B3       49.7       28.4       15.13       6.82       -0.179       0.622         B4       49.7       28.4       15.14       6.83       -0.116       0.819         B5       49.7       28.3       13.2       5.98       -0.285       0.833         2       C1       49.7       29.3       19.11       8.35       -0.451       1.312         C2       49.7       29.6       17.15       7.42       -0.099       0.546         C3       49.7       28.6       20.49       9.18       -0.407       1.066         C4       49.7       28.7       19.12       8.53       -0.2069       0.872         C4       49.7       29.3       17.14       7.49       -0.2069       0.872         C5       49.7       29.4       21.12       9.2      0.314       1.081         D2       49.7       28.6       21.07       9.44       -0.328       1.078         D3       49.7       28.6       21.07       9.44       -0.328       1.078         D4       49.7       32.5       21.09       8.31       -0.398       1.049         D4       49.7       28.2       23.06 </td <td></td> <td></td> <td>B2</td> <td>49.7</td> <td>28.6</td> <td>17.14</td> <td>7.68</td> <td>-0.285</td> <td>1.113</td>			B2	49.7	28.6	17.14	7.68	-0.285	1.113
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			B3	49.7	28.4	15.13	6.82	-0.179	0.622
B5       49.7       28.3       13.2       5.98       -0.285       0.833         2       C1       49.7       29.3       19.11       8.35       -0.451       1.312         C2       49.7       29.6       17.15       7.42       -0.099       0.546         C3       49.7       28.6       20.49       9.18       -0.407       1.066         C4       49.7       28.7       19.12       8.53       -0.256       1.225         C5       49.7       29.3       17.14       7.49       -0.2069       0.872         4       D1       49.7       29.4       21.12       9.2       -0.314       1.081         D2       49.7       28.6       21.07       9.44       -0.328       1.685         D3       49.7       28.6       21.07       9.44       -0.328       1.078         D4       49.7       28.6       21.07       9.44       -0.328       1.049         D4       49.7       32.5       21.09       8.31       -0.398       1.049         D4       49.7       28.2       23.06       10.47       -0.429       1.335 <td></td> <td></td> <td>B4</td> <td>49.7</td> <td>28.4</td> <td>15.14</td> <td>6.83</td> <td>-0.116</td> <td>0.819</td>			B4	49.7	28.4	15.14	6.83	-0.116	0.819
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			B5	49.7	28.3	13.2	5.98	-0.285	0.833
C2       49.7       29.6       17.15       7.42       -0.099       0.546         C3       49.7       28.6       20.49       9.18       -0.407       1.066         C4       49.7       28.7       19.12       8.53       -0.256       1.225         C5       49.7       29.3       17.14       7.49       -0.2069       0.872         4       D1       49.7       29.4       21.12       9.2      0.314       1.085         D2       49.7       28.4       27.05       12.2       -0.589       1.685         D3       49.7       28.6       21.07       9.44       -0.328       1.078         D4       49.7       32.5       21.09       8.31       -0.398       1.049         D4       49.7       32.5       23.06       10.47       -0.429       1.335		2	C1	49.7	29.3	19.11	8.35	-0.451	1.312
C3       49.7       28.6       20.49       9.18       -0.407       1.066         C4       49.7       28.7       19.12       8.53       -0.256       1.225         C5       49.7       29.3       17.14       7.49       -0.2069       0.872         4       D1       49.7       29.4       21.12       9.2       -0.314       1.081         D2       49.7       28.4       27.05       12.2       -0.589       1.685         D3       49.7       28.6       21.07       9.44       -0.328       1.078         D4       49.7       32.5       21.09       8.31       -0.398       1.049         D4       49.7       28.2       23.06       10.47       -0.429       1.335			C2	49.7	29.6	17.15	7.42	-0.099	0.546
C4       49.7       28.7       19.12       8.53       -0.256       1.225         C5       49.7       29.3       17.14       7.49       -0.2069       0.872         4       D1       49.7       29.4       21.12       9.2      0.314       1.081         D2       49.7       28.4       27.05       12.2       -0.589       1.685         D3       49.7       28.6       21.07       9.44       -0.328       1.078         D4       49.7       32.5       21.09       8.31       -0.398       1.049         D5       49.7       28.2       23.06       10.47       -0.429       1.335			C3	49.7	28.6	20.49	9.18	-0.407	1.066
C549.729.317.147.49-0.20690.8724D149.729.421.129.20.3141.081D249.728.427.0512.2-0.5891.685D349.728.621.079.44-0.3281.078D449.732.521.098.31-0.3981.049D549.728.223.0610.47-0.4291.335			C4	49.7	28.7	19.12	8.53	-0.256	1.225
4D149.729.421.129.20.3141.081D249.728.427.0512.2-0.5891.685D349.728.621.079.44-0.3281.078D449.732.521.098.31-0.3981.049D549.728.223.0610.47-0.4291.335			C5	49.7	29.3	17.14	7.49	-0.2069	0.872
D249.728.427.0512.2-0.5891.685D349.728.621.079.44-0.3281.078D449.732.521.098.31-0.3981.049D549.728.223.0610.47-0.4291.335		4	D1	49.7	29.4	21.12	9.2	0.314	1.081
D349.728.621.079.44-0.3281.078D449.732.521.098.31-0.3981.049D549.728.223.0610.47-0.4291.335			D2	49.7	28.4	27.05	12.2	-0.589	1.685
D449.732.521.098.31-0.3981.049D549.728.223.0610.47-0.4291.335			D3	49.7	28.6	21.07	9.44	-0.328	1.078
D5 49.7 28.2 23.06 10.47 -0.429 1.335			D4	49.7	32.5	21.09	8.31	-0.398	1.049
			D5	49.7	28.2	23.06	10.47	-0.429	1.335

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